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EXPERIMENTS IN CONTROLLING CORN EAR PESTS IN PUERTO RICO

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EXPERIMENTS IN CONTROLLING CORN EAR PESTS IN PUERTO RICO

By Wallace K. Bailey, *associate horticulturist*

Fine sweet corn can be produced in Puerto Rico for northern markets in winter months.

In 1934, as a culmination of 16 years' breeding and selection work, this experiment station made available to the farmers of Puerto Rico USDA–34 sweet corn. With favorable soil-moisture conditions and moderate fertilization this variety can be grown successfully in Puerto Rico throughout the entire year. There is no fresh corn on the New York market for 5 to 6 months each year during the late fall, winter, and early spring, but no attempts have been made to supply this market from Puerto Rico chiefly because of the prevalence and severity of earworm infestations.

In addition to the corn earworm (*Heliothis armigera* Hbn.) there are two other important insect pests of sweet corn ears on the island, the fall armyworm (*Laphygma frugiperda* (A. and S.)) and the corn-silk fly (*Euxesta stigmatias* Loew).

Corn earworms are a factor in sweet corn production in Puerto Rico.

Most corn earworm eggs are laid on the silks of an ear, usually within the first week after the silks appear and before pollination becomes effective and the exposed ends of the silks die. Almost immediately upon hatching the small larvae crawl down into the tip of the ear and begin feeding on the silks there, gradually working down to the ear proper. When the adults of the corn earworm are abundant, eggs are sometimes laid on parts of the plant other than the silks and the resulting larvae are frequently already partly grown when they enter the ears.

Larvae of fall armyworm infest ears of sweet corn in Puerto Rico.

In most sections of Puerto Rico eggs of the fall armyworm are laid on the lower side of the leaves beginning with young corn plants soon after they come up. The newly hatched larvae feed on the leaves for a few days, gradually working their way into the whorl of young leaves surrounding the growing point, where most of their feeding is done. In the later stages of development of the plants the larvae feed also on the husk leaves and in the shank where they are protected from their natural enemies. Larvae in various stages of development usually enter the ear by way of the silks but sometimes they enter directly through the husks, most frequently at the point where the ear is in contact with the stalk.

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Corn-silk fly was first reported as pest of corn in Puerto Rico in 1917.

The corn-silk fly has been a much more widespread pest of sweet corn in Puerto Rico than have the other two insects and is by far the most difficult to control.

Judging from the descriptions given, this insect was first reported as a pest of corn in Puerto Rico by Van Zwaluwenburg, former entomologist of the station.[1] The insect was called the corn-silk fly by Van Zwaluwenburg. A more complete study of the corn-silk fly was made by App, assistant entomologist of the Bureau of Entomology and Plant Quarantine, while stationed at Mayaguez during 1936.[2]

Usually the eggs of the corn-silk fly are laid just below the tip of the husks on the inside soon after the silks have grown out. The eggs are slender and white and are frequently found in strings fastened end to end; they are so small that they are just barely visible to the naked eye under favorable light conditions. Infested ears may con-

FIGURE 1.—Larvae of the corn-silk fly (*Euxesta stigmatias* Loew) typical of those found in ears of USDA–34 sweet corn at the proper stage for green consumption. Larvae are shown as approximately twice normal size.

tain from a few dozen to several hundred eggs. The eggs hatch in 2 to 4 days, and the young larvae feed on the silks, gradually working down inside the husks to the developing ear. A single infested ear may contain from a few to several hundred larvae. The larvae are white with darker spiracles and mouth parts, and on first hatching are very small. When full grown they are about three-eighths of an inch long and the dark-colored spiracles stand out against the white background. Larvae in various stages of development are shown in figure 1.

The life cycle of the corn-silk fly is short; as many as 20 generations per year are possible.

Under laboratory conditions the length of the larval stage was found by App to vary from about 6.5 to 9 days and the pupal stage from approximately 6.5 to 8 days. The larvae leave the ears to pupate and there is some evidence to indicate that the pupal stage is passed in the soil.

The adult is a small fly of a dark metallic green color with reddish eyes and wings banded with black. The flies are abundant in cornfields, and often several females have been observed ovipositing on the same ear. Under laboratory conditions App reared the fly from

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[1] VAN ZWALUWENBURG, R. H. REPORT OF THE ENTOMOLOGIST. Porto Rico Agr. Expt. Sta. Rpt. 1917: 33. 1918.

[2] APP, BERNARD A. EUXESTA STIGMATIAS LOEW, AN OTITID FLY INFESTING EAR CORN IN PUERTO RICO. Puerto Rico Univ. Jour. Agr. 22: 181–188, illus. 1938.

egg to adult in as few as 18 days. Therefore, under conditions of favorable food supply there are probably as many as 20 generations of these flies per year.

Corn-silk fly larvae decrease market value of sweet corn ears.

Usually the corn-silk fly larvae have done little or no damage to the kernels of infested ears by the time the corn reaches the best edible stage for green consumption, but the silks in the end of the husks of infested ears and the end of the cobs have become a sodden, decaying, malodorous, brown mass containing numerous fly larvae. Thus the corn-silk fly is a pest of primary importance to sweet corn ears for green consumption, not because of damage to the kernels but because infested ears are unsightly and have a decreased market value.

Under conditions unfavorable for immediate pollination, the feeding of corn-silk fly larvae may damage the silks to such an extent before pollination that poorly filled ears result.

The damage to field corn and to seed ears of sweet corn is usually confined to the destruction of a few kernels at the tip of the ears. In some cases, however, the larvae work down between the rows of kernels near the cob, destroying the kernels as they go. The work of the larvae is not infrequently followed by a fungus infection. Such infection may be confined chiefly to the injured kernels or those adjacent to them, but it has been observed to affect several rows of kernels and even entire ears, especially when the seed ears are allowed to mature and dry on the stalks in the field. While the end of the ear is still tender the larvae frequently bore into the cob, at times almost completely destroying it for a distance of 2 inches or more from the tip even when the kernels on the tip of the ear are not badly damaged.

Frequently 100 percent of corn ears have been infested with corn-silk fly larvae.

Van Zwaluwenburg reported that in June 1917, more than 75 percent of the ears in a cornfield at the station were found either infested with corn-silk fly larvae or with eggs in the silk tuft. App examined green-corn ears in fields in many different sections of the island and found corn-silk fly larvae present in all fields examined, usually infesting a large majority of the ears. Infestation counts at Isabela and at Mayaguez at different seasons of the year varied from 28 percent to 97 percent; most of the counts were well over 67 percent. Infestation counts at the station during the last 3 years have been even higher; in most cases 100 percent of the untreated ears examined have been infested.

Although no special studies on the control of the corn-silk fly were made by App, some data were accumulated in conjunction with experiments to control the corn earworm. There were 10 different treatments included in the experiment, of which 4 were insecticidal dust mixtures and 6 involved various types of mechanical protection. Those methods that covered the ear or constricted the husk near the tip of the ear gave better results than other methods. Nevertheless, none of the treatments gave satisfactory control; with the most effective treatment the control was only 45.15 percent.

Experiments were begun to determine an effective method of control for corn ear pests.

In May 1938 a series of experiments was begun with USDA–34 sweet corn in an attempt to work out a satisfactory control not only for the corn-silk fly but for the corn earworm and fall armyworm as well.

In the continental United States the commercial production of sweet corn has been confined largely to the northern half of the country chiefly because of the ravages of the corn earworm. Many different methods of controlling this destructive insect have been tested but at the time these experiments were begun no satisfactory control had yet appeared in the literature. On the continent, competition in the production of green ear corn for market is so keen that as a rule profits are not large. As a consequence, with control measures for the corn earworm, considerable emphasis has necessarily been placed on cheapness of control treatments.

The local market for sweet corn is so small that it is doubtful whether any control measures worked out for corn ear pests here will ever be used on corn for local consumption. However, in experimental shipments fresh green sweet corn shipped to the States during the winter months when there was no fresh corn from other sources on the market yielded high prices. It therefore seems possible that Puerto Rican growers may use more expensive methods for controlling corn ear pests and still make reasonable profits, which might not be possible in the summer months in the continental United States. This understanding has been the basis of the experiments conducted by the station at Mayaguez in attempting to work out a satisfactory method of controlling the corn ear pests of the island.

Ends of ears were protected to reduce insect infestation.

The first experiment tested the possibility of protecting the silks and ear tips from insect infestation at all times except for a period sufficiently long for effective pollination to take place. Young sweet corn ears were covered with glassine bags as soon as they appeared above the bases of their subtending leaf sheaths and before the silks came out. As soon as most of the rapidly growing silks had attained a length of 3 to 5 inches, four series of ears well distributed over the field were uncovered and their silks exposed for pollination for 4, 24, 36, and 168 hours, respectively. The silks were exposed at approximately 10 a. m., and in order to facilitate pollination, the stalks of all plants in the field were rapped sharply with a stick to cause anthers to dehisce and pollen to fly. Following the silk-exposure treatments the ears were covered with 2-pound manila paper bags to protect them from further insect infestation.

Ends of ears were clipped off to aid in reducing insect infestation.

In the first three series, the silks and the tips of the husks were cut from alternate ears in each series approximately 24 hours after the ears had been covered with the paper bags. This delay in clipping off the ends of the ears was made to allow sufficient time for the pollen on the silks to germinate and penetrate the silks to well below the ear tips. The ear tips were exposed only momentarily during the clipping operation. With the 168-hour treatment the ears were clipped immediately before they were covered with paper bags. Following

clipping the bags were allowed to remain on the ears undisturbed until the ears were harvested.

Ears were harvested and examined at roasting-ear stage of development.

All ears were harvested at the roasting-ear stage and immediately examined for extent of filling of the ear as well as for the presence of insect larvae. Separate records were taken for each ear, the presence or absence of both species of earworms or the small, corn-silk fly larvae being recorded. It is difficult to distinguish the larvae of the corn earworm from those of the fall armyworm; since both are known to be present in the island and since they caused the same kind of damage no attempt was made to separate them, and both types are mentioned together. The presence of a single larva of any one of the three ear pests was sufficient for an ear to be classified as infested.

Protecting silks for period prior to pollination resulted in poorly filled ears.

The filling of the ears was unsatisfactory even when the silks were exposed for 168 hours. Only 10.4 percent of the ears were well filled following the 4-hour exposure, 53 percent as a result of the 24-hour exposure, and only 61 percent after 168 hours' exposure.

A summary of the results of the insect infestation counts are shown by treatments in table 1.

TABLE 1.—*Summary of ear-infestation data for USDA–34 sweet corn following different silk-exposure treatments and different methods of handling ears following silk exposures, May 1938*

Period of silk exposure (hours)	Ears covered with paper bags				Ears clipped and covered with paper bags [1]			
	Total examined	Infested with corn earworms or fall armyworms	Infested with corn-silk fly larvae	Uninfested	Total examined	Infested with corn earworms or fall armyworms	Infested with corn-silk fly larvae	Uninfested
	Number	*Percent*	*Percent*	*Percent*	*Number*	*Percent*	*Percent*	*Percent*
4	81	39.3	65.4	13.6	44	36.4	27.3	45.5
24	89	67.4	61.8	3.4	65	38.5	24.6	46.2
36	92	65.2	76.1	3.3	66	37.9	28.8	45.5
168	77	29.9	94.8	0	43	37.2	51.2	30.2
All periods	339	56.3	74.0	5.0	218	37.6	31.7	42.7

[1] Clipped ears were those from which the tip end of the husks and the silks had been removed by a cut from one-half to three-fourths of an inch below the tip of the husks.

A 4-hour exposure of silks resulted in 86.4 percent of infested ears.

One outstanding result of the experiment was that when the silks and ear tips had been exposed to pollination for only 4 hours and covered again, 39.3 percent of the ears were infested with corn earworms or fall armyworms, 65.4 percent were infested with corn-silk fly larvae, and only 13.6 percent were uninfested. Even when the ends of the ears were clipped off after the exposure of the silks to pollination, only 45.5 percent of the ears that were exposed for 4 hours were uninfested. Obviously the methods used in this experiment could not be considered to have efficiently controlled either the large-type larvae or the corn-silk fly larvae.

Clipping off ends of ears following silk exposures reduced corn-silk fly infestation.

However, it can be seen in table 1 that clipping off the ends of the ears and covering the ears with paper bags following the silk-exposure treatments effected relatively large and consistent reductions in the proportion of ears infested with corn-silk fly larvae and a comparatively large increase in proportion of uninfested ears. Less striking but consistent, except for the 168-hour exposure, were the reductions in proportion of ears infested with corn earworms or fall armyworms.

In a later experiment where the tips of all ears were clipped before the ears were covered with paper bags and where exposures of 3, 4, 5, and 6 days were given, the results of the insect-infestation counts were similar to those for the first experiment except that the proportion of ears infested with corn earworms or fall armyworms was smaller and the percentage of uninfested ears larger. In the first experiment an average of 42.7 percent of the clipped ears were uninfested whereas in the second experiment 58.1 percent of the ears were uninfested.

Silks were allowed to develop and be pollinated normally in later experiments.

Examination of the husk development of a large number of ears of USDA–34 sweet corn at silking time revealed that the husks extended from at least 1 inch to often more than 2 inches beyond the tips of the developing ears. Furthermore, at the stage where the silks were beginning to wilt noticeably, even though most of the ears were already infested, rarely was there any evidence that the different types of larvae had penetrated as far as the tip of the developing ear.

Therefore, in view of the promising response to clipping observed in the first experiment, ears were selected both on Las Mesas and at the lowlands of the experiment station for test of various combinations of clipping and covering the ears after the silks had been allowed to develop normally to the stage where they began to wilt.

There were three treatment groups in the experiment: In one the ears were clipped but not covered; in another the ears were clipped and covered with paper bags until harvest; and in the third the ears were neither clipped nor covered. The ears chosen for each treatment were well distributed over the planting both on Las Mesas and at the lowland station. The ears were harvested at the roasting-ear stage and records were taken of the worm infestation and the extent of filling of each ear in the same manner as described for the first experiment.

The proportion of poorly filled ears was negligible on Las Mesas and amounted to only approximately 26 percent at the lowland station. The results of the combined larval infestation counts at Las Mesas and at the lowland station are shown in table 2.

Clipping and covering ears failed to control corn earworms and fall armyworms.

It will be noted from table 2 that clipping the ears without covering was of no value in controlling the corn-silk fly, and of questionable value as an aid in controlling the corn earworm and the fall armyworm. All of the untreated check ears and those that were clipped but not covered were infested with at least one type of larvae.

TABLE 2.—*Summary of results of different treatments of ears of USDA–34 sweet corn in controlling corn ear pests, June 1938*

Treatment	Ears examined	Ears infested with—		Ears uninfested
		Corn earworms or fall armyworms	Corn-silk fly larvae	
	Number	*Percent*	*Percent*	*Percent*
Ears unclipped and uncovered, check	272	14.0	99.6	0
Ears clipped and uncovered	116	11.2	100.0	0
Ears clipped and covered	286	17.8	18.5	67.5

On the other hand, 67.5 percent of the ears that were both clipped and covered were free from larvae of any type. Clipping and covering the ears reduced the proportion infested with corn-silk fly larvae to 18.5 percent. However, under the conditions of this experiment clipping and covering failed to control corn earworms and fall armyworms; in fact, this treatment resulted in an increase of 27.1 percent in the proportion of ears so infested as compared with the untreated checks.

As compared with ears that were clipped but not covered, clipping and covering the ears resulted in a 58.9-percent increase in proportion of ears infested with the corn earworm or the fall armyworm. Compared with the untreated ears, clipping alone effected a 20-percent reduction in proportion of ears infested with the corn earworm or the fall armyworm but failed to result in a reduction of ears infested with corn-silk fly larvae.

A possible explanation for the failure of the clipping-and-covering method to control the corn earworm and the fall armyworm was that the larvae of these two insects crawled in beneath the bags and infested the ears; the bag protected them from numerous predatory wasps that frequented the cornfields and possibly other natural enemies also.

The infestation counts of the corn-silk fly larvae do not present a complete picture of the conditions that actually existed, for many of the ears listed as infested in the clipped and covered groups contained only one or two larvae, whereas the ears so listed in other groups usually contained a larger number of larvae.

However, the 67-percent control effected by the clipping-and-covering treatment was still too low to be considered as an effective commercial treatment for controlling these corn ear pests.

Clipping off tips of ears partially controlled the corn earworm in Kentucky.

Insofar as clipping off the ends of the ears is concerned, the results of this experiment are not in agreement with results of similar treatments by Emmert [3] in Kentucky. Working with three varieties of sweet corn during the summer of 1937, Emmert obtained reductions of approximately 37 to 90 percent in ears infested with the corn ear-

[3] EMMERT, E. A PRELIMINARY REPORT ON A METHOD FOR CONTROLLING EARWORMS BY CLIPPING OFF TIPS OF EARS. Amer. Soc. Hort. Sci. Proc. (1937) 35: 573-575. 1938.

worm as a result of clipping off the tips of the ears at the time the ends of the silks began to dry and removing the clippings from the field.

However, the ear clippings were not removed from the fields in the Mayaguez experiments nor was a large proportion of the ears in the fields clipped. Inasmuch as the corn earworms are known to leave one ear and infest another and at times even a third, and inasmuch as Emmert observed that earworms from clippings allowed to fall to the ground near the plants crawled up the stalks and reinfested the clipped ears, the differences in the results obtained with clipping off the ends of corn ears in Kentucky and in Puerto Rico do not seem altogether illogical.

New series of experiments tested effectiveness of light, highly refined mineral oil.

During the summer of 1938 an account of the results of the use of a light, highly refined mineral oil in controlling the corn earworm in sweet corn ears in the continental United States was published by Barber.[4] As high as 89-percent control was obtained with the application of mineral oil to the silks in the ends of the husks following pollination.

Although the earworm situation in Puerto Rico is complicated by the corn-silk fly, during the fall of 1938 a new series of earworm-control experiments was started in which mineral oil was included together with other treatments.

In all the experiments in this new series the ears were selected in advance of the treatments and the treatments were so distributed that the results could be analyzed statistically by analysis-of-variance procedure. The treatments were alternated in a series of replications in which each replication group contained one ear from each treatment. In order to facilitate treating the ears and recording the results, previous to the application of treatments all ears selected for a given experiment were marked with enamel paint applied on the stalk near the ear to be treated. A different color of paint was used for each treatment. Except where otherwise noted the ears in the experiments were harvested at the roasting-ear stage of development, 12 to 14 days after the treatments were applied, and immediately after harvest all ears were examined for the presence of larvae. The infestation records were obtained in the manner described for previous experiments.

The mineral oil used in these experiments was of a type suitable for medicinal purposes and is not considered harmful to humans if taken in small quantities.[5]

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[4] BARBER, G. W. NEW CONTROL METHODS FOR THE CORN EAR WORM. Jour. Econ. Ent. 31: 459. 1938.

[5] Two kinds of oil were used in the experiments. One was a widely-advertised proprietary mineral oil, the other a bulk mineral oil sold in Puerto Rico under the name "vaselina liquida." Insofar as could be determined by these experiments both kinds were equally effective in controlling the insects in question. The properties of the two oils as determined by the Bureau of Entomology and Plant Quarantine are as follows:

Property:	*Proprietary oil*	*Bulk oil*
Specific gravity 15°/15° C	0.887	0.847
Viscosity, Saybolt Sec. 100° F	399	94
Volatility, percent, 4 hours at 110° C	.10	.11
Iodine No., Hanus	0	0
Acid value (Mg. KOH per gram)	.02	.03
Unsulfonatable residue, percent by volume	100	100

Mineral oil was tested with various combinations of clipping and covering the ears.

The first experiment in the new series was designed to test the comparative effectiveness of mineral oil when used in conjunction with different combinations of clipping off the ends of the ears and covering them. In one treatment the ears were clipped and covered with glassine bags; in another the ears were clipped, approximately 1 milliliter of a light, highly refined mineral oil was applied to the cut surface of the clipped ears, and the ears were covered with tightly fitting glassine bags; and in the third, the ears were clipped and mineral oil was applied but the ears were not covered. An untreated series of ears was included in the experiment as a check. There were 60 ears in each of the treatments and in the untreated check. The oil was applied by means of an ordinary medicine dropper. The treatments given and a summary of the results obtained are shown in table 3.

TABLE 3.—*Summary of results of different treatments of ears of USDA–34 sweet corn in controlling corn ear pests, October 1938*

Treatment [1]	Corn-silk fly		Corn earworm or fall armyworm		Both types of larvae		Uninfested ears
	Ears infested	Control effected	Ears infested	Control effected	Ears infested	Control effected	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Ears clipped and covered	25.0	74.1	25.0	53.0	45.0	55.0	55.0
Ears clipped, oiled, and covered	16.7	82.7	6.7	87.4	21.7	78.3	78.3
Ears clipped and oiled but not covered	70.0	27.6	13.3	75.0	73.3	26.7	26.7
Check, or no treatment	96.7	0	53.3	0	100.0	0	0

[1] 60 ears per treatment.

It can be seen from table 3 that all check ears were infested with some type of larvae, 96.7 percent with larvae of the corn-silk fly and 53.3 percent with fall armyworms or corn earworms. All treatments were superior to the check to a highly significant degree.

Mineral oil failed to effectively control corn-silk fly.

With regard to corn-silk fly infestation, clipping and covering the ears effected 74.1-percent control, whereas clipping the ears and applying mineral oil without covering resulted in only 27.6-percent control. Clipping the ears and applying mineral oil followed by covering gave 82.7-percent control. These results indicate strikingly that covering the ends of the ears after clipping was far more effective in controlling the corn-silk fly than was the application of mineral oil. There was no statistically significant difference between the control effected by clipping and covering and clipping plus mineral oil and covering, but each of these two treatments was superior in a highly significant manner to the treatment that included clipping and mineral oil without covering.

However, the figures in table 3 do not tell the complete story. Almost all check ears contained numerous larvae of the corn-silk fly, some more than 100, and in most cases the larvae had reached the tips of the ears by the time they were harvested. When the ends of

the husks were clipped off and mineral oil was applied without covering, in most cases few larvae were present; sometimes only one or two could be found and in almost every case those present were small and had not yet penetrated far enough down the silks to reach the tips of the developing ears. This indicated that with most of the ears receiving this treatment, infestation by corn-silk fly larvae took place later than with the check ears and that either fewer eggs were laid or the oil effectively reduced the number of eggs that hatched or larvae that survived.

Mineral oil effectively reduced corn earworm and fall armyworm infestation.

The results of the control measures with fall armyworms and corn earworms were different from those with the corn-silk fly. Clipping and covering the ears effected the least control, only 53 percent, whereas both treatments which included mineral oil gave significantly superior control, 75 percent for the uncovered ears and 87.4 for the covered ones. The difference between the covered ears that received mineral oil and the uncovered ones receiving the oil was not statistically significant.

On the basis of total infestation, i. e. infestation by either type of larvae, 73.3 percent of the ears were infested following clipping and the application of mineral oil, 45 percent of the ears that were clipped and covered were infested, and 21.7 percent were infested following clipping, application of oil, and covering. The treatment consisting of clipping, the application of oil, and covering was superior in a highly significant way to the one involving clipping and covering only, and the latter was superior in a similar degree to the treatment that included clipping and the application of oil without covering. The 78.3-percent control effected by clipping, application of oil, and covering was beginning to approach what might be considered satisfactory commercial control.

Effectiveness of two applications of mineral oil was investigated.

The results of this experiment indicated that the use of mineral oil alone in two applications might effectively control all three corn ear pests. Accordingly, an experiment was designed to compare the effectiveness of one and of two applications of mineral oil used alone and used in conjunction with clipping off the ends of the ears.

There were 124 ears in each of the 4 treatments and the untreated check. The initial treatments were made April 3, and the second application of oil followed 5 days later. The mineral oil was applied by means of a medicine dropper at the rate of approximately 1 milliliter of oil per application per ear. The other details of procedure were the same as for the preceding experiment.

The treatments applied and a summary of the results obtained are shown in table 4.

Clipping failed to increase effectiveness of mineral oil.

Table 4 shows that from the standpoint of corn-silk fly control, clipping the ears was of no value when used in conjunction with the application of mineral oil. In no case was the control of the insects in clipped ears superior to that in those not clipped, and there was evidence to indicate that the use of clipping in combination with

mineral oil resulted in significantly poorer control than did the use of mineral oil alone.

TABLE 4.—*Summary of results of different treatments of ears of USDA–34 sweet corn, in controlling corn ear pests, May 1939*

Treatment [1]	Corn-silk fly		Corn earworm or fall armyworm		Uninfested ears
	Ears infested	Control effected	Ears infested	Control effected	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Check, or no treatment	100.0	0	34.6	0	0
Mineral oil, 1 application	95.2	4.8	3.1	91.0	4.0
Ears clipped; mineral oil, 1 application	98.5	1.5	4.0	88.3	1.6
Mineral oil, 2 applications	89.5	10.5	1.6	95.4	9.7
Ears clipped; mineral oil, 2 applications	100.0	0	1.6	95.4	0

[1] 124 ears in each treatment.

Two applications of mineral oil failed to control corn-silk fly.

The most outstanding result of the experiment was that none of the treatments reduced the corn-silk fly infestation sufficiently to be considered an acceptable commercial control measure. The most effective treatment gave only 10.5 percent control. However, with many of the ears to which oil was applied, especially the unclipped ones, the larvae were smaller and fewer in number and had done far less damage to the silks and ears than those in the untreated check ears.

Mineral oil effectively controlled corn earworms and fall armyworms.

Mineral oil, both alone and in combination with clipping, gave excellent control of fall armyworms and corn earworms, one application being almost as effective as two. All treatments including mineral oil were statistically equal in this respect; the poorest control for any such treatment was 88.3 percent and the best 95.4 percent. Clipping was apparently of no value in controlling fall armyworms and corn earworms.

It was evident from the results of this experiment that some insecticide that would effectively control the corn-silk fly was needed for mixing with the mineral oil to control all three of the corn ear pests.

A 1:3 pyrethrum-extract and mineral-oil mixture effectively controlled corn-silk fly in laboratory.

In connection with the clipping of the ears in the above experiment it was found that the clippings, consisting of the ends of the husks and silks, were heavily infested with all three insect pests. In order to determine whether or not pyrethrum extract mixed with mineral oil would aid in the control of the corn-silk fly, the clippings from 200 ears were divided into 15 approximately equal lots. Five of the lots were saturated with a liberal quantity of mineral oil, 5 with a 1:3 mixture of pyrethrum extract with mineral oil and 5 lots were left untreated to serve as checks. Each lot was placed loosely in a small cotton bag and all 15 bags were moistened slightly on the outside and wrapped in moist blotting paper. The pyrethrum used was an alcoholic extract containing 2.4 percent of pyrethrins.

When examined 4 days later the untreated clippings were heavily infested with both the large- and small-type larvae, the five oil-

treated lots were heavily infested with corn-silk fly larvae only, and the pyrethrum-oil-treated lots were all free from living larvae of any type. To check more carefully on the results with the pyrethrum-oil mixture, the clippings of each lot so treated were examined under the microscope. Not a single living larva was found in any of the five lots.

Effectiveness of pyrethrum-extract and mineral-oil mixture in controlling corn-silk fly was given field test.

In the meantime, a field experiment was designed to test the comparative effectiveness of two applications of mineral oil and a mixture of pyrethrum extract and mineral oil when used alone and in combination with clipping. The details of the handling of the experiment were the same as described for the previous field experiment. There were 99 ears in each of the 5 treatments. The mixture of pyrethrum extract and mineral oil consisted of 1 part of an alcoholic pyrethrum extract containing 2.4 percent of pyrethrins to 3 parts of mineral oil. The first applications were made May 4 and the second May 8. The ears were harvested May 16, 12 days after they were first treated.

The treatments used and a summary of the results obtained are presented in table 5.

TABLE 5.—*Summary of results of different treatments of ears of USDA–34 sweet corn in controlling corn ear pests, May 1939*

Treatment [1]	Corn-silk fly		Corn earworm or fall armyworm		Uninfested ears
	Ears infested	Control effected	Ears infested	Control effected	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Check, or no treatment	98.0	0	19.0	0	2.0
Mineral oil, 2 applications	96.0	2.0	0	100.0	4.0
Pyrethrum-extract and mineral-oil mixture, 2 applications	0	100.0	0	100.0	100.0
Ears clipped+mineral oil, 2 applications	99.0	1.0	1.0	94.8	0
Ears clipped+pyrethrum-extract and mineral-oil mixture, 2 applications	0	100.0	2.0	88.5	98.0

[1] 99 ears in each treatment.

Clipping was of no value in controlling any of the three corn ear pests.

It is evident from table 5 that 98 percent of the untreated check ears were infested with corn-silk fly larvae, but only 19.0 were infested with corn earworms or fall armyworms.

It can be seen further that more of the clipped ears receiving mineral oil were infested with corn-silk fly larvae than those not clipped and receiving mineral oil, and the same was true for corn earworms and fall armyworms. This demonstrated a second time that clipping, when used in conjunction with mineral oil, was of no apparent value in controlling any of these corn ear pests.

Two applications of 1:3 pyrethrum-extract and mineral-oil mixture controlled corn-silk fly perfectly.

When applied to unclipped ears, two applications of mineral oil gave perfect control of the corn earworm and the fall armyworm, but again failed to control the corn-silk fly. However, two applications of the mixture of pyrethrum extract and mineral oil resulted in perfect control of the corn-silk fly when applied to either clipped or unclipped

ears and perfect control of the fall armyworm and corn earworm when applied to unclipped ears.

In another experiment involving three treatments with 68 ears per treatment, the effectiveness of two applications of a mixture of pyrethrum extract and mineral oil, applied to both clipped and unclipped ears, was tested against that of two applications of mineral oil alone applied to clipped ears. The details of procedure were the same as those in the other field experiments. The first applications were made May 8, the second May 12, and the ears were harvested and records taken May 20. A summary of the results is shown in table 6.

TABLE 6.—*Summary of results of different treatments of ears of USDA–34 sweet corn in controlling corn ear pests, May 1939*

Treatment [1]	Ears infested with—		Uninfested ears
	Corn-silk fly	Corn earworm or fall armyworm	
	Percent	*Percent*	*Percent*
Mineral oil, 2 applications	98.5	0	1.5
Pyrethrum-extract and mineral-oil mixture, 2 applications	0	0	100.0
Ears clipped+pyrethrum-extract and mineral-oil mixture, 2 applications	1.5	1.5	97.0

[1] 68 ears in each treatment.

Pyrethrum-extract and mineral-oil mixture controlled all three ear pests almost perfectly in second field experiment.

The results of this second experiment involving pyrethrum were equally as striking and clear-cut as those of the first field experiment. Under conditions where 98.5 percent of the ears treated with two applications of mineral oil were infested with corn-silk fly larvae, two applications of a 1:3 mixture of pyrethrum extract with mineral oil gave perfect control. When applied to unclipped ears, both the mineral oil and the pyrethrum-extract and mineral-oil mixture controlled corn earworms and fall armyworms perfectly, and when the latter treatment was applied to clipped ears, only 1 ear of 68 was so infested. The extent of the corn earworm and fall armyworm infestation in untreated ears was not determined.

A 1:4 pyrethrum-extract and mineral-oil mixture effectively controlled corn-silk fly larvae.

During the latter part of May, the effectiveness of a single application of a 1:4 mixture of pyrethrum extract and mineral oil was tested against corn-silk flies in seed ears of USDA–34 sweet corn. This was an unusually severe test in that the ears were 10 days farther advanced in development when treated than had been the case in earlier experiments. As a result, most of the ears were already heavily infested with corn-silk fly larvae in advanced stages of development at the time treatment was applied. Four rows of corn were chosen for the test; each row was divided in 4 sections, each 50 feet long. Ten ears in each alternate section in all 4 rows were given the pyrethrum-extract-mineral-oil treatment and 10 ears in each of the remaining 8 sections were selected as checks. The ears were harvested for seed 3 weeks after treatment and the ear tips were examined for evidence of corn-silk fly larval injury.

Of the 80 untreated ears 77, or 96 percent, had been damaged by the larvae, whereas only 2, or 2.5 percent, of the ears to which the 1:4 mixture of pyrethrum extract and mineral oil had been applied showed evidence of injury. Typical treated and untreated ears are shown in figure 2.

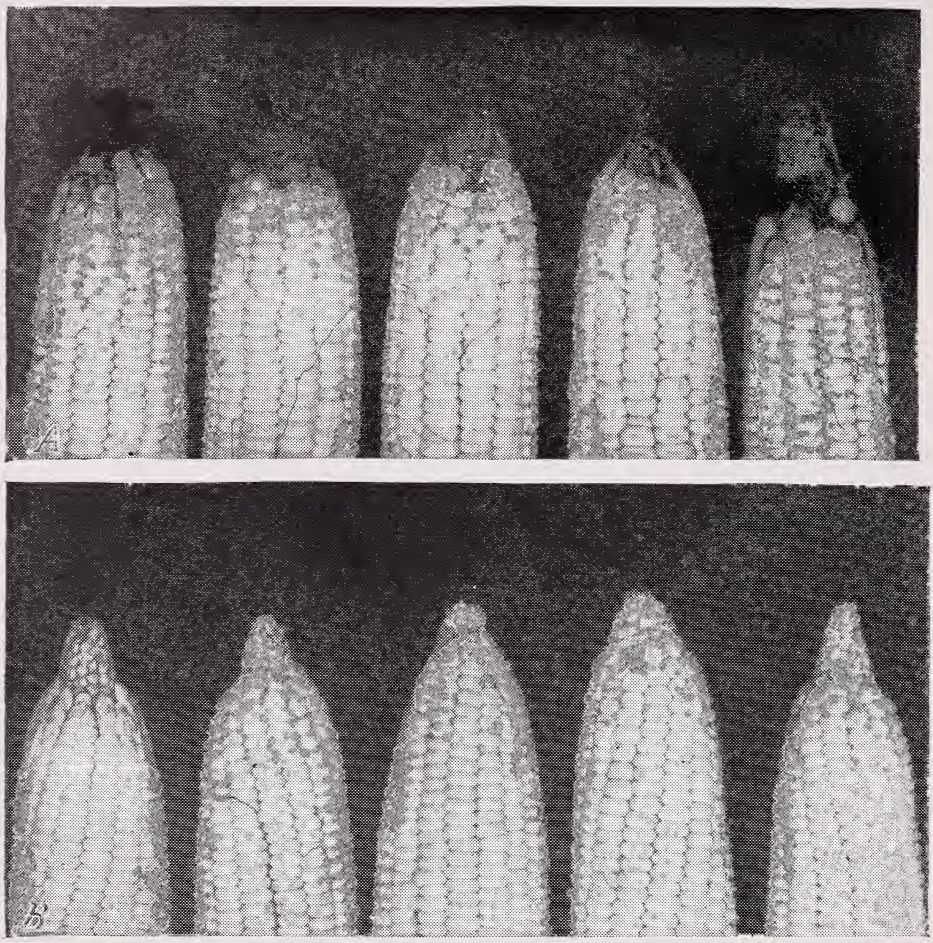

FIGURE 2.—Seed ears of USDA–34 sweet corn: *A*, Untreated ear tips showing damage from corn-silk fly infestations; *B*, ears treated with single applications of a 1:4 pyrethrum-extract and mineral-oil mixture for the control of earworms and corn-silk fly larvae, showing clean, undamaged tips.

Effectiveness of different concentrations of pyrethrum extract was tested.

Two experiments were conducted in order to test the comparative effectiveness of different concentrations of pyrethrum extract used in conjunction with mineral oil and in order to ascertain whether two applications of the mixture were necessary to control earworm and corn-silk fly infestation. In the first experiment the proportions of pyrethrum to mineral oil were 1:5, 1:25, 1:50, 1:75, and 1:100. Two applications of these mixtures were made, the first May 26 and the second June 2. In the second experiment the same strengths of pyrethrum-extract and mineral-oil mixtures were used, but only one application was made, May 27, 1 day later than in the first experiment, using ears many of which were on the same plants or on plants

adjacent to those included in the first experiment. There were 84 ears per treatment in the first experiment and 72 per treatment in the second; equal numbers of untreated ears served as checks. The details of procedure in these two experiments were the same as for the other field experiments.

The treatments used and the results of the two experiments are summarized in table 7.

TABLE 7.—*Summary of results of treating ears of USDA–34 sweet corn with different-strength pyrethrum-extract and mineral-oil mixtures, June 1938*

Treatment	Ears infested with corn-silk fly larvae following—	
	1 application [1]	2 applications [2]
Pyrethrum-extract and mineral-oil mixture:	*Percent*	*Percent*
1:5	11.1	6.0
1:25	68.1	33.3
1:50	94.4	77.4
1:75	97.2	90.5
1:100	97.2	94.0
Untreated check	100.0	100.0

[1] 84 ears in each treatment.
[2] 72 ears in each treatment.

Two applications gave uniformly more satisfactory control of corn-silk fly than one application.

Inasmuch as only 5 of the 936 ears included in the test were found to be infested with large earworms the results in table 7 and in the discussion are confined to the corn-silk fly only.

It can be seen from the table that all untreated check ears were infested with corn-silk fly larvae; and further, uniformly more satisfactory results were obtained with two applications of the pyrethrum-extract and mineral-oil mixture than with one. With the 1:100 mixture the control was more than twice as great with two applications as with one, and with the 1:75 mixture the control was 3.4 times as effective with two applications as with one. As compared with a single application, two applications were four times as effective in controlling the larvae when the 1:50 mixture was used and more than twice as effective with the 1:25 mixture. However, it was only with the 1:25 mixture that the difference in the control effected by two applications and that effected by one was sufficiently great to be considered statistically significant.

Only the 1:5 pyrethrum-extract and mineral-oil mixture effectively controlled the corn-silk fly.

However, by far the most striking feature of the results of these two experiments was that, regardless of the number of applications, only the 1:5 mixture,[6] with 88.9-percent control for one application and 94 percent for two applications, resulted in control of the corn-silk fly sufficiently effective to be considered a good commercial control for this insect pest. The results of the treatments are shown graphically in figure 3.

[6] Containing approximately 0.4 percent pyrethrins.

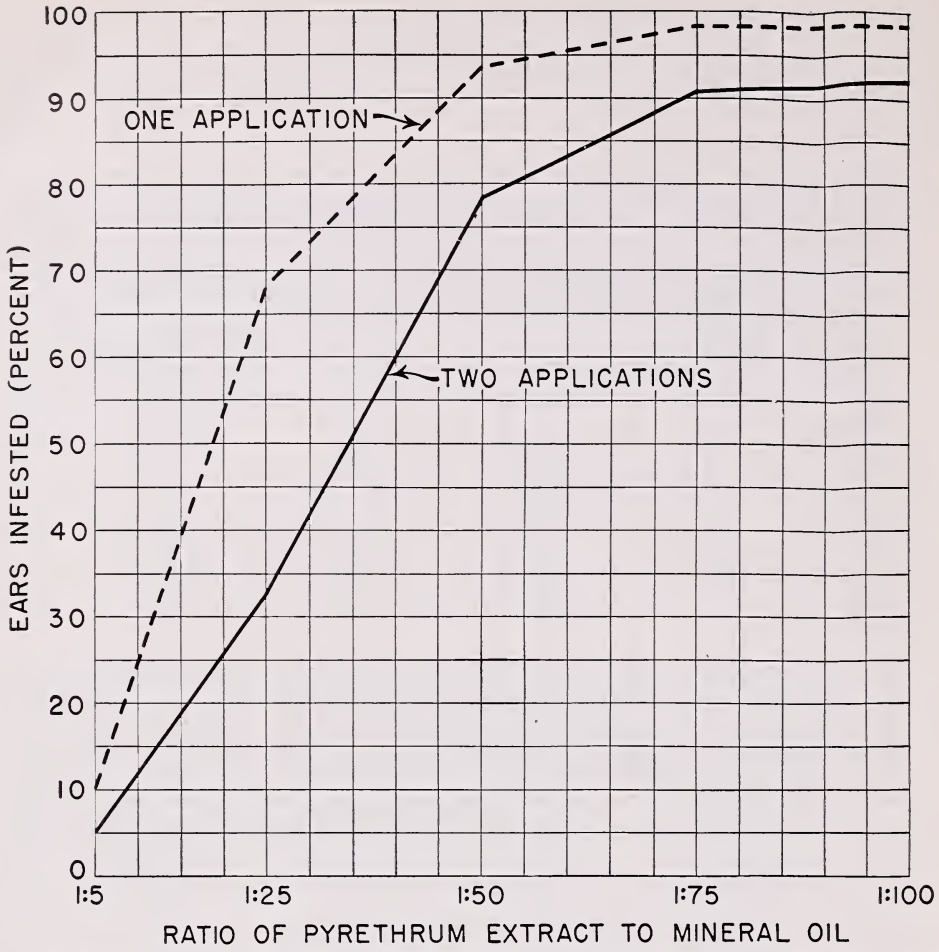

FIGURE 3.—Infestation of ears of USDA–34 sweet corn with corn-silk fly larvae resulting from different treatments with pyrethrum-extract and mineral-oil mixtures.

Typical untreated ears and ears treated with a 1:5 pyrethrum-extract and mineral-oil mixture are shown in figure 4.

Derris powder increased effectiveness of 1:25 pyrethrum-extract and mineral-oil mixture.

As an insecticide, pyrethrum, once it has been applied, is not considered to retain its effectiveness over a long period. On the other hand rotenone-containing insecticides such as derris products are slower in acting and retain their effectiveness over a longer period provided they are not exposed to direct sunlight.

An experiment was started May 30, 1939, to ascertain whether the effectiveness of a mixture of pyrethrum extract and mineral oil of a given concentration would be increased by the addition of derris powder containing 1 percent of rotenone. The five treatments consisted of 1:5 and 1:25 mixtures of pyrethrum extract with mineral oil applied alone and with the addition of a derris powder containing 1 percent of rotenone at the rate of 1 ounce of powder per quart of mixture and an untreated check. There were 57 ears in each treatment; the treatments were made and the results recorded in the manner described for previous experiments.

None of the ears included in the experiment was found to be infested with corn earworms or fall armyworms, but 100 percent of the check, or untreated, ears were infested with corn-silk fly larvae.

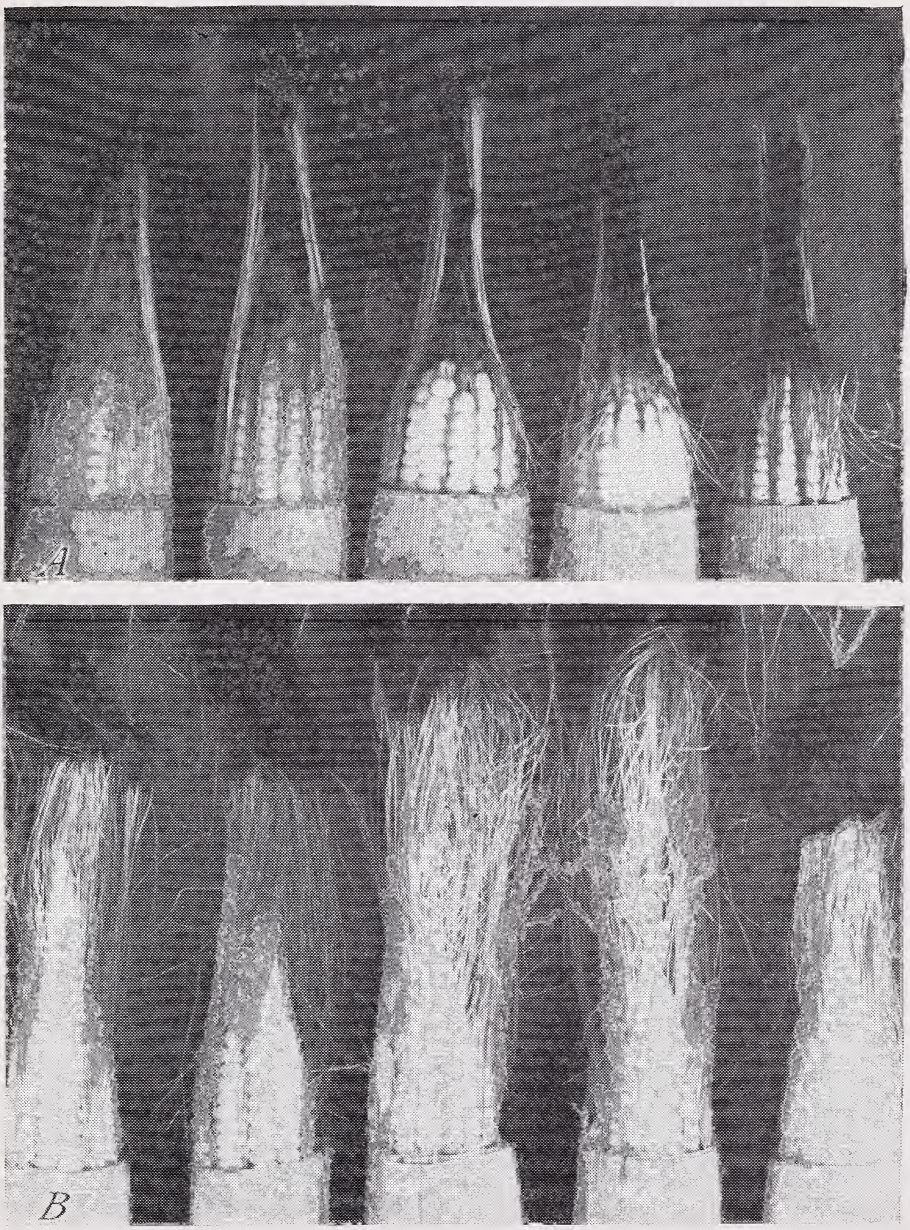

FIGURE 4.—Ears of USDA–34 sweet corn at roasting-ear stage of development: *A*, Typical untreated ears, all infested with corn-silk fly larvae, and silks a decayed, sodden, malodorous, brown mass; *B*, ears treated with a 1: 5 pyrethrum-extract and mineral-oil mixture, showing clean, intact silks.

The addition of derris powder to a 1:5 mixture of pyrethrum extract with mineral oil did not increase the effectiveness of the mixture in controlling corn-silk fly larvae. Of the 57 ears in each of the 2 treatments only 4, or 7 percent, were infested. However, the addition of derris powder to a 1:25 mixture of pyrethrum extract with mineral oil increased the effectiveness of the mixture almost fourfold,

from 15.7 percent control for pyrethrum and oil alone to 77.1 percent control for the pyrethrum-oil mixture to which derris had been added.

The effectiveness of various combinations of pyrethrum extract, derris extract, and mineral oil was tested.

The results of this experiment suggested the possibility that the pyrethrum in the mixture of pyrethrum extract with mineral oil might advantageously be supplemented by a rotenone-containing insecticide or might even be replaced to advantage by such an insecticide. Inasmuch as the derris powder used in the last experiment was difficult to keep in proper suspension, a proprietary derris-extract plant spray was substituted for the powder in the subsequent experiments. The manufacturers recommended that the derris extract be applied as a general plant insecticide at about the same dilution as that recommended for pyrethrum extract. Therefore, in the experiments that followed both extracts were used in equal proportions.

Because of a scarcity of ears in the proper stage of development for treatment, none of the experiments contained untreated ears as checks. Frequent careful examination of a total of more than 100 untreated ears not included in the experiment revealed that all ears so examined were infested with corn-silk fly larvae. The extent of corn earworm or fall armyworm infestation varied widely in different sections of the field.

The effectiveness of water as a substitute for oil in the insecticidal mixture was tested.

The first experiment in this new series was designed primarily to determine whether or not water could be used as a satisfactory substitute for the mineral oil in the insecticidal mixtures.

Pyrethrum extract and derris extract were applied separately mixed with oil in the proportion of 1:25 and in the same proportion mixed with water; the fifth treatment was a 1:25 mixture of pyrethrum extract and derris extract with mineral oil in which equal parts of pyrethrum extract and derris extract were used. There were 85 ears in each treatment. The treatments were applied August 6 and the ears harvested and the records taken 12 days later. The other details of procedure were the same as for previous field experiments. The treatments applied and a summary of the results obtained are shown in table 8.

Water was not a satisfactory substitute for mineral oil.

There was little difference effected in the control of corn-silk fly by the pyrethrum extract and derris extract when both were mixed with water, and the difference between these two treatments in the control of the corn earworm and fall armyworm was not statistically significant.

An outstanding result of the experiment was that the pyrethrum extract and derris extract were of practically no value in reducing the insect infestation when they were applied mixed with water. More than 90 percent of the ears receiving the two treatments were infested with at least one type of larvae. In the control of both types of larvae these two treatments were significantly inferior to the three treatments which included mineral oil.

TABLE 8.—*Summary of results of different treatments of ears of USDA–34 sweet corn in controlling corn ear pests, September 1939*

Treatment [1]	Ears infested with—		Total ears infested	Ears uninfested
	Corn-silk fly	Corn earworm or fall armyworm		
	Percent	*Percent*	*Percent*	*Percent*
Pyrethrum extract and water, 1:25	87.1	36.5	91.7	8.3
Derris extract and water, 1:25	88.2	43.5	90.6	9.4
Pyrethrum extract and mineral oil, 1:25	41.2	17.6	50.6	49.4
Pyrethrum extract, derris extract, and mineral oil, 1:25	40.0	17.6	52.9	47.1
Derris extract and mineral oil, 1:25	55.3	11.8	62.4	37.6

[1] 85 ears in each treatment.

Derris extract was not as effective as pyrethrum extract in controlling corn-silk fly.

There were no statistically significant differences among the three treatments including mineral oil, in the proportion of uninfested ears and in the proportion of ears infested with corn earworms or fall armyworms. The proportion of ears infested with corn-silk fly larvae was significantly higher for the ears receiving the mixture of derris extract with mineral oil than for those receiving the mixture containing pyrethrum extract and mineral oil. There was almost no difference in the efficiency with which the corn-silk fly was controlled by the mixture of pyrethrum extract with mineral oil and the mixture of pyrethrum extract, derris extract, and mineral oil. However, with none of the treatments was the proportion of uninfested ears sufficiently large for any one of them to be considered a good commercial control for the corn ear pests. Even with the most efficient treatment the control was less than 50 percent.

Different concentrations of combinations of pyrethrum extract, derris extract, and mineral oil were tested.

Additional experiments were conducted in which only those treatments utilizing mineral oil were included. In these experiments the proportions of the supplements to mineral oil were adjusted to 1:5, 1:10, 1:15, 1:20, 1:30, and 1:40. The 1:5 and 1:10 mixtures were applied September 5, with 64 ears per treatment; the 1:15 and 1:20 mixtures were applied the same day but in a different section of the field, with 67 ears per treatment; and the 1:30 and 1:40 mixtures were applied 5 days later with 65 ears in each treatment. All treated ears were harvested 12 days after treatment and the infestation examinations were made immediately. However, only 60 ears for each treatment at each concentration were used in the statistical analysis of the data. The treatments applied and a summary of the results of the ear-infestation counts for corn-silk fly, corn earworm, and fall armyworm larvae are shown in table 9.

TABLE 9.—*Summary of results of treating ears of USDA–34 sweet corn with different mixtures of insecticides for the control of corn ear pests, September 1939*

Treatment	Ears infested with larvae following treatment with—					
	[1] 1:5	[1] 1:10	[1] 1:15	[1] 1:20	[1] 1:30	[1] 1:40
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
CORN-SILK FLY						
Pyrethrum extract and mineral oil	1.7	8.3	16.6	28.3	40.0	56.7
Pyrethrum extract, derris extract, and mineral oil [2]	3.3	20.0	18.3	21.7	51.7	68.3
Derris extract and mineral oil	10.0	25.0	31.7	43.3	63.3	70.0
CORN EARWORM OR FALL ARMYWORM						
Pyrethrum extract and mineral oil	13.3	35.0	20.0	26.7	33.3	21.7
Pyrethrum extract, derris extract, and mineral oil [2]	0	8.3	16.7	23.3	21.7	28.3
Derris extract and mineral oil	0	1.7	5.0	10.0	25.0	28.3
CORN EARWORM, FALL ARMYWORM, OR CORN-SILK FLY						
Pyrethrum extract and mineral oil	16.7	40.0	35.0	45.0	63.3	65.0
Pyrethrum extract, derris extract, and mineral oil [2]	1.7	26.7	35.0	38.3	63.3	81.3
Derris extract and mineral oil	10.0	25.0	33.3	43.3	81.3	78.3

[1] Ratio of supplementary insecticide to mineral oil.
[2] The supplementary insecticide consisted of one-half pyrethrum extract and one-half derris extract.

Derris-extract and mineral-oil treatment gave poorest control of corn-silk fly.

It can be seen in table 9 that a higher proportion of the ears was infested with corn-silk fly larvae following treatment with derris extract and mineral oil at all concentrations tested than following the other two treatments. With the 1:10, 1:15, 1:20, and 1:30 concentrations the proportion infested following the treatment with derris extract and mineral oil was significantly higher than that for the treatment with pyrethrum extract and mineral oil. When the 1:20 concentration of derris extract and mineral oil was used the infestation was significantly higher than that resulting from the treatment with pyrethrum extract, derris extract, and mineral oil. At the 1:5 concentration all three treatments gave what could be considered satisfactory commercial control, as did also the treatment with pyrethrum and mineral oil at 1:10. The proportion of ears infested varied among these four combinations from 1.7 percent for the 1:5 treatment with pyrethrum extract and mineral oil, to 10 percent for the treatment with 1:5 derris extract and mineral oil.

Derris-extract and mineral-oil mixture was particularly effective in controlling corn earworms and fall armyworms.

In table 9 it will be noted also that with the exception of the 1:40 concentration, the two treatments containing derris extract gave more effective control of the corn earworm and fall armyworm than the treatment with pyrethrum extract and mineral oil. With the 1:5 and 1:10 concentrations the control effected by both the derris-extract and mineral-oil and the pyrethrum-extract, derris-extract, and mineral-oil combinations was significantly superior to that effected by pyrethrum extract and mineral oil. There was no significant effect of treatment for the 1:15 and 1:20 and for the 1:30 and 1:40

concentrations insofar as control of corn earworm and fall armyworm was concerned. The combination of derris extract and mineral oil controlled these two pests perfectly when applied as a 1:5 mixture; only 1.7 percent of the ears were infested when the mixture was applied in the proportion of 1:10, 5 percent were infested following a 1:15 concentration, and 10 percent following a 1:20 concentration mixture. The combination of pyrethrum extract, derris extract, and mineral oil controlled corn earworms and fall armyworms perfectly when applied in the proportion of 1:5; 8.3 percent of the ears were infested following treatment with the 1:10 concentration and 16.7 percent following the 1:15 mixture. Following the treatment with 1:5 pyrethrum extract and mineral oil, 13.3 percent of the ears were infested with corn earworms or fall armyworms.

Only 1.7 percent of ears treated with 1:5 pyrethrum extract, derris extract, and mineral oil were infested.

From the standpoint of ears infested with any one of the three kinds of larvae, table 9 shows that only 1.7 percent infestation followed the treatment with 1:5 pyrethrum extract, derris extract, and mineral oil, whereas 10 percent were infested following the treatment with derris extract and mineral oil, and 16.7 percent following the application of pyrethrum extract and mineral oil. The differences among these treatments were not statistically significant. Regardless of the supplementary insecticide used concentrations more dilute than 1:5 resulted in control too low to warrant consideration from a commercial standpoint.

Treatments including derris extract caused burning of husks.

From the results of these data it would seem that either the derris and mineral oil or the combination of pyrethrum extract, derris extract, and mineral oil would be preferable to the pyrethrum extract and mineral oil as a control measure for the three corn ear pests. However, the treatments in which derris extract was included caused objectionable injury to the husks. This burning was especially notable with the 1:5 and 1:10 concentrations. The burning was more severe with the mixture of derris extract and mineral oil than with the combination of pyrethrum extract, derris extract, and mineral oil, but the burning occasioned by the latter was still severe enough to be considered objectionable. A few ears were burned as a result of the use of a 1:5 pyrethrum-extract and mineral-oil mixture but objectionable injury was not severe enough to preclude the use of the treatment as a commercial control.

A 1:5 pyrethrum-extract and mineral-oil mixture is recommended.

These experiments were conducted under conditions varying from severe drought where irrigation was necessary and no rain fell during the treatment period to excessive rainfall with heavy showers occurring on an average of 4 to 5 days each week during the growth of the corn and during the treatment period.

The results indicate that under conditions similar to those under which these experiments were conducted, the use of a single application of a 1:5 mixture of pyrethrum extract and mineral oil could be expected to give satisfactory control of the corn-silk fly, the corn earworm, and the fall armyworm; two applications might give even better control, especially under conditions where heavy infestations of corn earworms and fall armyworms occur.

Considerable care is necessary in the application of the mixture, as its presence interferes with further pollination of the ears. Although a little experience is necessary in order that the insecticide may not be applied too soon, usually practically all of the kernels, with the exception of a few at the very tip, will have been fertilized by the time the silks wilt noticeably and begin to dry at the tips. Inasmuch as corn earworms frequently migrate from ear to ear it would seem to be sound practice to treat all ears in a given field regardless of their size. Another alternative would be to not treat ears that will unmistakably be culls but remove them from the field as soon as the other ears have been treated.

As a supplement to the treatment with pyrethrum extract and mineral oil, it is recommended that in preparing green sweet corn for market after harvesting, the end of the husks and the dried silks be cut off at a distance of approximately one-half to three-fourths of an inch from the tip.

Obviously these methods cannot be expected to control fall armyworms that enter the ears directly through the husks on the sides or at the base of the ears. However, it has been found that the proportion of ears so infested is of little consequence except possibly under conditions of unusually high infestation.

Oiler developed by Bureau of Entomology and Plant Quarantine facilitates treatment of sweet corn ears.

The use of a medicine dropper in applying the treatment mixture was time-consuming and is not recommended unless better facilities are unavailable. The Bureau of Entomology and Plant Quarantine has developed an oiler specifically for expediting the treatment of sweet corn ears with mineral oil for the control of corn earworms in the continental United States. This oiler has been described in detail and well illustrated by Barber,[7] who developed it. By means of the oiler a measured quantity of oil can be applied to each ear; the quantity applied can be varied by an adjustment on the oiler. Two types of oilers have been developed, one a complete unit in itself and the other designed to be attached by a small-diameter hose to a knapsack sprayer where an oil reservoir is maintained under pressure. The complete unit-type oiler has been found at the station to be satisfactory for handling the mixture of pyrethrum extract and mineral oil.

Two applications of a 1:5 pyrethrum-extract and mineral-oil mixture can be applied at a cost of approximately 1.8 cents per dozen ears.

The cost of treating sweet corn ears with a 1:5 mixture of pyrethrum extract and mineral oil would necessarily vary with the cost of the supplies and the efficiency of the labor in applying the treatment. With USDA–34 sweet corn it would be necessary to go over the field twice in order to be able to treat most of the ears. With an interval of 5 or 6 days between the first and second trips through the field, only a few scattered ears that were late in developing would escape treatment. Assuming that one man could cover an acre during an 8-hour day, 2 man-days would be required to treat an acre of sweet corn if one application of oil were made and 4 man-days would

[7] BARBER, GEORGE W. THE USE OF OIL FOR EAR WORM CONTROL IN SWEET CORN. U. S. Bur. Ent. and Plant Quar. E–476, 6 pp., illus. Mimeographed.]

be required for two applications. On this basis, with pyrethrum extract at $8 a gallon, mineral oil at 80 cents a gallon, and labor $1 per day, the total cost of treating an acre of 10,000 ears of sweet corn would amount to approximately $7.50 for one application and $15 for two. This would be a cost of approximately 0.075 cent per ear, or 0.9 cent per dozen ears, for one application, and 0.15 cent per ear, or 1.8 cents per dozen ears, for two applications.

Puerto Rican farmers can supply New York market with sweet corn during winter.

Although an additional production cost of $7.50 to $15 per acre might be considered high for sweet corn grown to supply the island demand, it would not seem to be excessive for sweet corn produced for marketing in the continental United States during the winter months when no fresh green corn is available and prices would be high.

Insofar as the production phase of the problem is concerned, the application of the results of these experiments in controlling the corn ear pests of the island now make it possible for Puerto Rican farmers to supply the New York market with high-quality, fresh, green sweet corn during the winter months.

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